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Monthly Performance Report

LUTZ-SOTIRE

MARCH 1979

U.S. Department of Energy

National Solar Heating and Cooling Demonstration Program

National Solar Data Program

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MONTHLY PERFORMANCE REPORT
LUTZ-SOTIRE
MARCH 1979

I. SYSTEM DESCRIPTION

The Lutz-Sotire solar energy system serves a three story, 25,000 square foot office building located in Stamford, Connecticut. This retrofit system supplies energy to a distributed heat pump system consisting of 64 water-to-air heat pump units connected in a closed hydronic loop. The solar collector array contains 2,561 square feet of collector area consisting of 138 flat-plate collectors augmented by 2,927 square feet of reflectors. The collectors are tilted at 55 degrees, the reflectors at 10 degrees from the horizontal. A 50 percent ethylene glycol solution is used as the energy collection and transport fluid. Solar energy is stored in water contained in a 6,000-gallon storage tank partially buried beneath the parking lot. From the storage tank, solar heated water is distributed to the building's heat pump loop. The existing electrical hot water boiler provides auxiliary energy.

Because the solar energy system supplies its energy to the heat pump hydronic loop, the terminology normally used in the National Solar Heating and Cooling Demonstration must be modified. Heating load normally applies to energy added to the air of the conditioned space; however, in this system it will be understood to refer to the energy demand on the equipment supplying energy to the heat pump hydronic loop. This energy is the sum of the solar and auxiliary energy extracted from those subsystem reservoirs and whatever energy may be added to the hydronic loop by individual heat pumps extracting heat from the conditioned space and placing it in the hydronic loop (cooling mode).

The Lutz-Sotire solar energy system, shown schematically in Figure 1, has the following modes of operation:

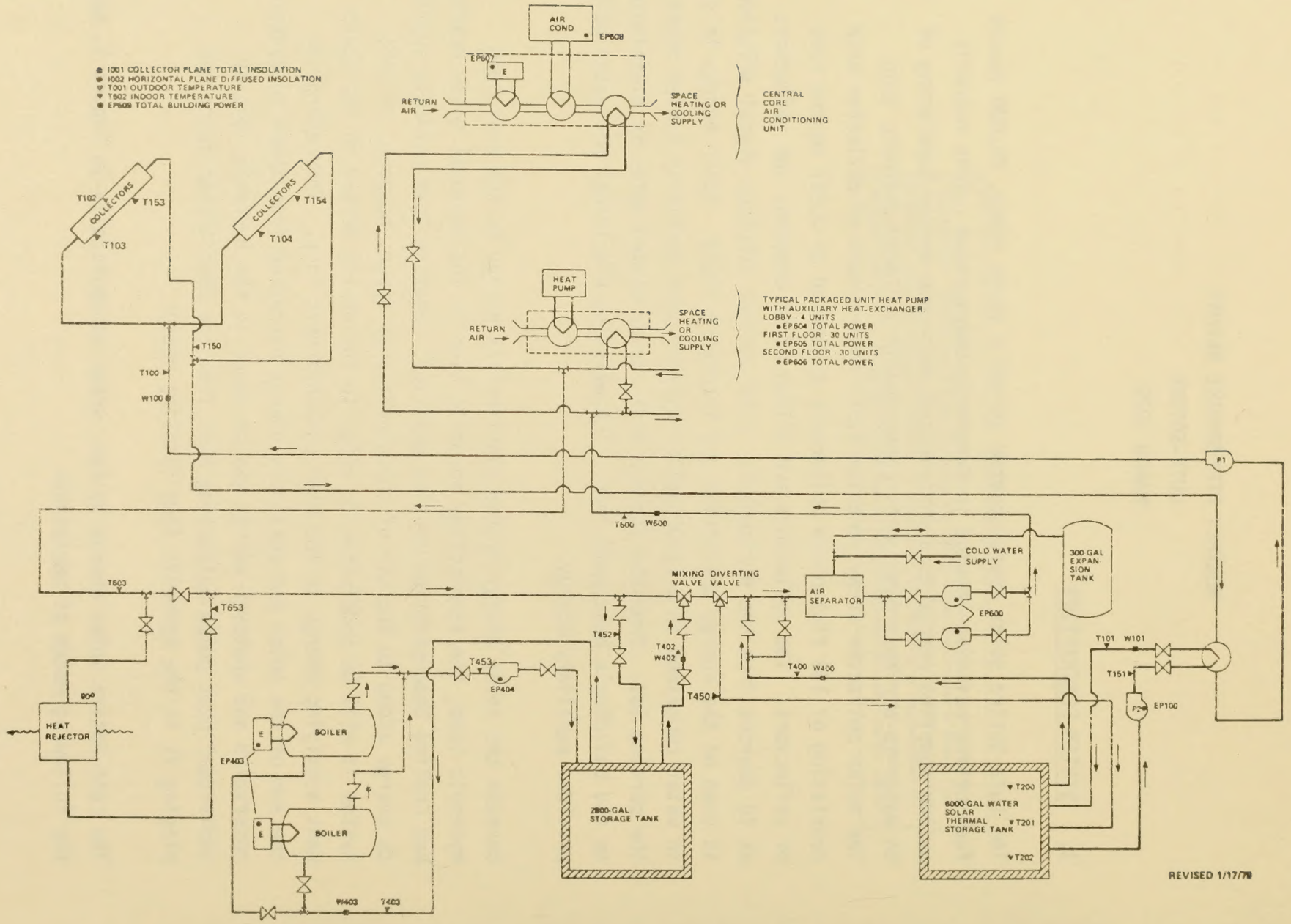

Figure 1. LUTZ-SOTIRE SOLAR ENERGY SYSTEM SCHEMATIC

Mode 1 - Collector-to-Storage: This mode is initiated whenever the collector plate temperature is approximately 20°F above the solar tank temperature. This mode is exited when this temperature differential drops below 5°F.

Mode 2 - Storage-to-Space Heating: This mode is initiated whenever the supply temperature of the closed cycle hydronic loop falls below 80°F and the temperature of the solar storage tank is above 75°F. Solar heated water is fed into the hydronic loop until its temperature rises to 80°F or until the temperature of the solar storage tank falls below 75°F.

Mode 3 - Auxiliary Heating: This mode is activated whenever the supply temperature of the closed cycle hydronic loop falls below 75°F. Water heated by the existing electrical boilers will be fed into the hydronic loop until the supply temperature rises to 75°F.

II. PERFORMANCE EVALUATION

The system performance evaluations discussed in this section are based primarily on the analysis of the data presented in the attached computer-generated monthly report. This attached report consists of daily site thermal and energy values for each subsystem, plus environmental data. The performance factors discussed in this report are based upon the definitions contained in NBSIR 76-1137, Thermal Data Requirements and Performance Evaluation Procedures for the National Solar Heating and Cooling Demonstration Program.

A. Introduction

The Lutz-Sotire solar energy system was operational throughout the month of March. It supplied 32.6 million Btu of energy to the hydronic loop serving the several heat pumps whose total demand was 31.0 million Btu. This represented 86 percent of the total energy supplied to the heat pump array and an estimated 57 percent of the space heating load.

Direct measurement of both the solar and auxiliary energy contributions to the hydronic loop are precluded by instrumentation problems. Estimations of these parameters based upon other measured data have been substituted for the missing measured data which has been nulled from the individual subsystem reports.

B. Weather

The average ambient temperature for the month was 42°F. This is compared with 41°F for a long-term average taken at the Bridgeport, Connecticut, weather station 30 miles to the north. The average insolation in the plane of the collector array was 1,235 Btu/ft^2-day as compared with 1,251 Btu/ft^2-day long-term average. This long-term prediction was obtained from the New York weather station 30 miles to the south.

C. System Thermal Performance

Collector - Of the 98.1 million Btu incident upon the collector array during the month, 36.0 million Btu were collected. This represents a collector array efficiency of 37 percent. Operating energy of 2.6 million Btu (767 kwh) was required to collect and store this energy.

Storage - From the 36.0 million Btu collected, 33.0 million Btu were delivered to storage. Diminished usage of the system in the heating mode allowed the average storage tank temperature to increase to 114°F. Because of an instrumentation incompatibility, energy removed from storage as normally tabulated on the Storage Performance Report has been nulled and a better estimate is obtained assuming the uncontrolled losses are 10 percent of the input energy and using the equation:

$$STEI = STEO + STECH + STLOSS$$

Solving for STEO

$$STEO = STEI - STECH - STLOSS$$
$$= 33.0 - (-2.9) - 3.3$$
$$= 32.6 \text{ million Btu}$$

Space Heating - Space heating at the Lutz-Sotire site is accomplished by 64 individual heat pumps which use as their source a hydronic loop whose temperature is maintained by solar and auxiliary sources. There is no direct contribution to the space heating load by solar energy. A tabulation of the energy removed from the hydronic loop by the heat pumps has been listed under the heading Space Heating Load on the Space Heating Subsystem report. This demand has resulted in a measured 31.0 million Btu being removed from the hydronic loop. A further discussion of this quantity is contained in Section D, Observations.

D. Observations

Using a technique developed in the December (Narrative) report on this site, a comparison figure for the hydronic loop demand as measured may be calculated. It should be noted that the total energy extracted from the hydronic loop should be approximately equal to the total energy delivered to storage plus the auxiliary electrical energy demand, for there are known uncontrolled losses to the environment. The energy removed from storage has already been calculated as 32.6 million Btu. It will be assumed that all of this energy was inserted into the hydronic loop.

Because the temperature of the auxiliary storage tank has in past months been maintained at a higher temperature than the solar tank, the losses have been assumed to be 20 percent of the total energy supplied. All of the remaining energy consumed by the electric boiler will be assumed to have been supplied to the hydronic loop. Despite evidence that the auxiliary tank temperature may have been decreased, the 20 percent transport and storage loss will continue to be assumed. As may be seen on the Space Heating Subsystem report, the total auxiliary energy consumed was 6.9 million Btu. It

will be assumed that 80 percent of this energy or 5.5 million Btu was actually inserted into the hydronic loop. It may be seen that the sum of the solar and auxiliary energy added to the hydronic loop is 38.1 million Btu. This figure is in reasonably good agreement with the measured load of 31.0 million Btu. During this month, in contrast to months previous, the estimated load has exceeded the measured load. It may be noted from the Storage Performance report that following operation on March 17, the temperature of the storage average temperature began to increase reaching a high of 180°F on March 23. The average temperature for the last 14 days of the month was 136°F compared with a total monthly average of 114°F. The 10 percent loss rate may not be applicable to the tank at this higher temperature.

It is believed that the total energy input to the hydronic loop is more nearly approximated by the sum of the auxiliary and solar energy contributions (modified for losses) than is the direct measurement at the load. Under this assumption, the solar fraction of the load can be calculated as

$$SFR = \frac{\text{solar energy}}{\text{solar energy + auxiliary energy + heat pump electrical energy}}$$

$$= \frac{32.6}{32.6 + 5.5 + 19.3} = 57 \text{ percent.}$$

E. Energy Savings

Based on the assumptions and calculation shown above, a total of 30.0 million Btu of energy savings was realized. This value assumes that had there been no solar energy system, all energy supplied to the hydronic loop would have come from the auxiliary source.

III. ACTION STATUS

A thorough reevaluation of the instrumentation subsystem at the site is in progress. Under consideration are:

(1) Increasing the existing voltage to all flowmeters and electrically converting them to totalizing meters, thus reducing threshold sensitivity to 5-7 gpm.

(2) Investigating and recalibrating where necessary all temperature sensors involved in the heat pump hydronic loop energy balance calculations.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: LUTZ-SOTIRE STAMFORD, CT. SOLAR/2027-79/03
REPORT PERIOD: MARCH,1979

SITE/SYSTEM DESCRIPTION:
LUTZ-SOTIRE IS A 3 STORY OFFICE BUILDING WITH 25,000 SQUARE FEET OF HEATED SPACE. THE SOLAR ENERGY SYSTEM IS A RETROFIT TO A DISTRIBUTED HEAT PUMP SYSTEM CONSISTING OF 70 WATER-TO-AIR HEAT PUMP UNITS CONNECTED IN A CLOSED CYCLE HYDRONIC LOOP. THE SOLAR SYSTEM CONSIST OF 138 FLAT PLATE COLLECTORS AUGMENTED BY REFLECTORS. A 50% ETHYLENE GLYCOL SOLUTION CIRCULATES THROUGH THE COLLECTORS TO A LIQUID-TO-LIQUID HEAT EXCHANGER. WATER FROM THE 6,000 GALLON STORAGE TANK CIRCULATES THROUGH THE OTHER SIDE. FROM THE STORAGE TANK, SOLAR HEATED WATER IS ALSO DISTRIBUTED TO THE BUILDING'S HEAT PUMP LOOP.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	98.064	MILLION BTU
	38291	BTU/SQ.FT.
COLLECTED SOLAR ENERGY	36.041	MILLION BTU
	14073	BTU/SQ.FT.
AVERAGE AMBIENT TEMPERATURE	42	DEGREES F
AVERAGE BUILDING TEMPERATURE	73	DEGREES F
ECSS SOLAR CONVERSION EFFICIENCY	@	
ECSS OPERATING ENERGY	2.618	MILLION BTU
TOTAL SYSTEM OPERATING ENERGY	4.799	MILLION BTU
TOTAL ENERGY CONSUMED	47.733	MILLION BTU

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL	
LOAD	N.A.	30.955	N.A.	8.216	MILLION BTU
SOLAR FRACTION	N.A.	@	N.A.	@	PERCENT
SOLAR ENERGY USED	N.A.	@	N.A.	@	MILLION BTU
OPERATING ENERGY	N.A.	2.181	N.A.	4.799	MILLION BTU
AUX. THERMAL ENERGY	N.A.	@	N.A.	0.185	MILLION BTU
AUX. ELECTRIC FUEL	N.A.	6.893	N.A.	6.893	MILLION BTU
AUX. FOSSIL FUEL	N.A.	N.A.	N.A.	N.A.	MILLION BTU
ELECTRICAL SAVINGS	N.A.	@	N.A.	@	MILLION BTU
FOSSIL SAVINGS	N.A.	N.A.	N.A.	N.A.	MILLION BTU

SYSTEM PERFORMANCE FACTOR: 0.211

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978, SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SITE SUMMARY

SITE: LUTZ-SOTIRE STAMFORD, CT. SOLAR/2027-79/03
REPORT PERIOD: MARCH,1979

SITE/SYSTEM DESCRIPTION:
LUTZ-SOTIRE IS A 3 STORY OFFICE BUILDING WITH 25,000 SQUARE FEET OF HEATED SPACE. THE SOLAR ENERGY SYSTEM IS A RETROFIT TO A DISTRIBUTED HEAT PUMP SYSTEM CONSISTING OF 70 WATER-TO-AIR HEAT PUMP UNITS CONNECTED IN A CLOSED CYCLE HYDRONIC LOOP. THE SOLAR SYSTEM CONSIST OF 138 FLAT PLATE COLLECTORS AUGMENTED BY REFLECTORS. A 50% ETHYLENE GLYCOL SOLUTION CIRCULATES THROUGH THE COLLECTORS TO A LIQUID-TO-LIQUID HEAT EXCHANGER. WATER FROM THE 6,000 GALLON STORAGE TANK CIRCULATES THROUGH THE OTHER SIDE. FROM THE STORAGE TANK, SOLAR HEATED WATER IS ALSO DISTRIBUTED TO THE BUILDING'S HEAT PUMP LOOP.

GENERAL SITE DATA:

INCIDENT SOLAR ENERGY	103.457 GIGA JOULES
	434835 KJ/SQ.M.
COLLECTED SOLAR ENERGY	38.024 GIGA JOULES
	159815 KJ/SQ.M.
AVERAGE AMBIENT TEMPERATURE	5 DEGREES C
AVERAGE BUILDING TEMPERATURE	23 DEGREES C
ECSS SOLAR CONVERSION EFFICIENCY	N.A.
ECSS OPERATING ENERGY	2.762 GIGA JOULES
TOTAL SYSTEM OPERATING ENERGY	5.063 GIGA JOULES
TOTAL ENERGY CONSUMED	50.358 GIGA JOULES

SUBSYSTEM SUMMARY:

	HOT WATER	HEATING	COOLING	SYSTEM TOTAL
LOAD	N.A.	32.65E	N.A.	8.668 GIGA JOULES
SOLAR FRACTION	N.A.	@	N.A.	@ PERCENT
SOLAR ENERGY USED	N.A.	@	N.A.	@ GIGA JOULES
OPERATING ENERGY	N.A.	2.301	N.A.	5.063 GIGA JOULES
AUX. THERMAL ENG	N.A.	@	N.A.	0.195 GIGA JOULES
AUX. ELECTRIC FUEL	N.A.	7.272	N.A.	7.272 GIGA JOULES
AUX. FOSSIL FUEL	N.A.	N.A.	N.A.	N.A. GIGA JOULES
ELECTRICAL SAVINGS	N.A.	@	N.A.	@ GIGA JOULES
FOSSIL SAVINGS	N.A.	N.A.	N.A.	N.A. GIGA JOULES

SYSTEM PERFORMANCE FACTOR: 0.211

* DENOTES UNAVAILABLE DATA
@ DENOTES NULL DATA
N.A. DENOTES NOT APPLICABLE DATA

REFERENCE: USER'S GUIDE TO THE MONTHLY PERFORMANCE REPORT OF THE NATIONAL SOLAR DATA PROGRAM,FEBRUARY 28,1978, SOLAR/0004-78/18

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENERGY COLLECTION AND STORAGE SUBSYSTEM (ECSS)

SITE: LUTZ-SOTIRE STAMFORD, CT. SOLAR/2027-79/03
REPORT PERIOD: MARCH,1979

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	AMBIENT TEMP DEG-F	ENERGY TO LOADS MILLION BTU	AUX THERMAL TO ECSS MILLION BTU	ECSS OPERATING ENERGY MILLION BTU	ECSS ENERGY REJECTED MILLION BTU	ECSS SOLAR CONVERSION EFFICIENCY
1	2.835	40	0.000		0.059		@
2	0.335	39	0.000		0.000		@
3	1.925	38	0.495		0.074		@
4	0.259	37	0.175		0.000		@
5	0.492	49	0.000		0.004		@
6	0.034	50	0.000		0.000		@
7	0.506	42	0.000		0.000		@
8	4.186	41	0.058		0.173		@
9	4.851	41	0.000		0.141		@
10	0.272	42	0.000		0.000		@
11	1.548	33	0.023		0.036		@
12	5.242	29	0.342		0.172		@
13	4.688	37	0.492		0.160		@
14	0.808	47	1.024		0.022		@
15	5.859	25	0.724		0.169		@
16	5.088	27	0.726		0.148		@
17	1.038	35	1.118		0.077		@
18	5.783	36	0.105		0.176		@
19	5.646	40	0.546		0.148		@
20	5.393	46	0.000		0.132		@
21	5.166	49	0.000		0.137		@
22	5.759	54	0.000		0.133		@
23	5.450	51	0.000		0.099		@
24	1.268	52	0.000		0.001		@
25	4.299	51	0.000		0.085		@
26	3.024	40	0.000		0.036		@
27	5.652	36	0.000		0.125		@
28	5.444	36	0.132		0.152		@
29	1.425	45	0.073		0.004		@
30	1.260	54	0.328		0.039		@
31	2.730	53	1.070		0.115		@
SUM	98.064	-	8.031	N.A.	2.618	N.A.	-
AVG	3.163	42	0.259	N.A.	0.084	N.A.	@
NBS ID	Q001	N113			Q102		N111

NOT APPLICABLE

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
COLLECTOR ARRAY PERFORMANCE

SITE: LUTZ-STORE STAMFORD, CT. SOLAR/2027-79/03
REPORT PERIOD: MARCH,1979

DAY OF MONTH	INCIDENT SOLAR ENERGY MILLION BTU	OPERATIONAL INCIDENT ENERGY MILLION BTU	COLLECTED SOLAR ENERGY MILLION BTU	DAYTIME AMBIENT TEMP DEG F	COLLECTOR ARRAY EFFICIENCY
1	2.835	1.574	0.894	50	0.315
2	0.335	0.000	0.000	40	0.000
3	1.925	1.650	0.963	42	0.501
4	0.259	0.000	0.000	38	0.000
5	0.492	0.018	0.002	52	0.004
6	0.034	0.000	0.000	50	0.000
7	0.506	0.000	0.000	44	0.000
8	4.186	3.929	1.999	47	0.477
9	4.851	4.151	2.022	50	0.417
10	0.272	0.000	0.000	45	0.000
11	1.348	0.747	0.364	33	0.270
12	5.242	4.765	2.351	34	0.449
13	4.688	4.330	2.362	*	0.504
14	0.808	0.421	0.189	*	0.234
15	5.859	5.195	2.573	26	0.439
16	5.088	4.339	2.486	32	0.489
17	1.038	0.797	0.142	*	0.137
18	5.783	5.213	2.766	45	0.478
19	5.646	4.763	2.479	49	0.439
20	5.393	4.214	1.812	53	0.336
21	5.166	4.232	1.892	60	0.366
22	5.759	4.594	1.992	70	0.346
23	5.450	2.824	1.416	68	0.260
24	1.268	0.062	0.000	59	0.000
25	4.299	2.874	0.755	58	0.176
26	3.024	1.460	0.591	45	0.196
27	5.652	4.360	1.935	43	0.342
28	5.444	4.632	1.965	46	0.361
29	1.425	0.315	0.364	49	0.256
30	1.260	0.633	0.337	62	0.267
31	2.730	2.451	1.391	57	0.509
SUM	98.064	75.544	36.041	-	-
AVG	3.163	2.437	1.163	48	0.368
NBSID	G001		G1CC		N100

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
STORAGE PERFORMANCE

SITE: LUTZ-SCTIRE STAMFORD, CT. SOLAR/2027-79/03
REPORT PERIOD: MARCH,1979

DAY OF MONTH	ENERGY TO STORAGE MILLION BTU	ENERGY FROM STORAGE MILLION BTU	CHANGE IN STORED ENERGY MILLION BTU	STORAGE AVERAGE TEMP DEG F	STORAGE EFFICIENCY
1	0.781	@	-0.698	125	@
2	0.000	@	-1.642	105	@
3	0.915	@	-0.403	85	@
4	0.000	@	-0.238	78	@
5	-0.005	@	-0.048	76	@
6	0.000	@	-0.006	76	@
7	0.000	@	-0.032	76	@
8	1.825	@	1.964	95	@
9	1.949	@	0.988	120	@
10	0.000	@	-1.666	117	@
11	0.272	@	-1.171	86	@
12	2.317	@	1.113	92	@
13	2.177	@	0.351	98	@
14	0.112	@	-0.705	99	@
15	2.489	@	0.510	98	@
16	2.311	@	0.046	95	@
17	0.251	@	-1.495	88	@
18	2.871	@	2.267	102	@
19	2.207	@	0.907	124	@
20	1.653	@	0.601	142	@
21	1.568	@	0.555	155	@
22	1.597	@	0.716	171	@
23	1.456	@	0.092	180	@
24	0.000	@	-1.567	168	@
25	0.776	@	0.213	151	@
26	0.364	@	-0.966	146	@
27	1.630	@	0.119	133	@
28	1.629	@	0.212	135	@
29	0.426	@	-1.804	118	@
30	0.336	@	-1.137	95	@
31	1.293	@	0.025	90	@
SUM	33.000	@	-2.900	-	-
AVG	1.065	@	-0.094	114	@
NBS ID	Q200	Q201	Q202		N108

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
SPACE HEATING SUBSYSTEM

SITE: LUTZ-SOTIRE STAMFORD, CT. SOLAR/2027-79/03
REPORT PERIOD: MARCH,1979

DAY OF MON.	SPACE HEATING LOAD MILLION BTU	SOLAR FR.OF LOAD PCT	SOLAR ENERGY USED MILLION BTU	CPER ENERGY MILLION BTU	AUX THERMAL USED MILLION BTU	AUX ELECT FUEL MILLION BTU	AUX FOSSIL FUEL MILLION BTU	ELECT ENERGY SAVINGS MILLION BTU	FOSSIL ENERGY SAVINGS MILLION BTU	BLDG TEMP DEG. F	AMB TEMP DEG. F
1	0.658	@	@	0.039	@	0.000	N	@	N	75	40
2	0.645	@	@	0.047	@	0.000	O	@	O	74	39
3	0.665	@	@	0.080	@	0.044	T	@	T	75	38
4	1.071	@	@	0.108	@	0.962		@		69	37
5	0.515	@	@	0.061	@	0.452	A	@	A	72	49
6	0.113	@	@	0.043	@	0.151	P	@	P	74	50
7	0.335	@	@	0.065	@	0.204	P	@	P	73	43
8	0.438	@	@	0.044	@	0.146	L	@	L	74	41
9	0.536	@	@	0.026	@	0.000	I	@	I	72	41
10	0.441	@	@	0.047	@	0.000	C	@	C	72	42
11	1.088	@	@	0.085	@	0.794	A	@	A	68	33
12	2.210	@	@	0.119	@	1.050	B	@	B	68	29
13	1.402	@	@	0.085	@	0.104	L	@	L	71	37
14	1.140	@	@	0.084	@	0.000	E	@	E	74	47
15	2.119	@	@	0.113	@	0.488		@		73	25
16	2.637	@	@	0.124	@	0.892		@		72	27
17	2.091	@	@	0.125	@	0.158		@		72	35
18	2.014	@	@	0.125	@	0.846		@		72	36
19	1.805	@	@	0.073	@	0.000		@		71	40
20	0.922	@	@	0.065	@	0.000		@		73	46
21	0.551	@	@	0.046	@	0.000		@		76	49
22	0.359	@	@	0.042	@	0.000		@		75	54
23	0.215	@	@	0.036	@	0.000		@		76	51
24	0.534	@	@	0.065	@	0.000		@		76	52
25	0.422	@	@	0.072	@	0.000		@		73	51
26	0.748	@	@	0.073	@	0.000		@		72	40
27	1.426	@	@	0.073	@	0.000		@		72	36
28	1.596	@	@	0.071	@	0.000		@		72	36
29	1.106	@	@	0.060	@	0.000		@		73	45
30	0.467	@	@	0.043	@	0.000		@		75	54
31	0.689	@	@	0.038	@	0.000		@		75	53
SUM	30.955	-	@	2.181	@	6.893	N.A.	@	N.A.	-	-
AVG	0.999	@	@	0.070	@	0.222	N.A.	@	N.A.	73	42
NBS	Q402	N400	Q400	Q403	Q401		Q410	Q415	Q417	N406	N113

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM

MONTHLY REPORT
ENVIRONMENTAL SUMMARY

SITE: LUTZ-SOTIRE STAMFORD, CT. SOLAR/2027-79/03
REPORT PERIOD: MARCH, 1979

DAY OF MONTH	TOTAL INSOLATION BTU/SQ.FT	DIFFUSE INSOLATION BTU/SQ.FT	AMBIENT TEMPERATURE DEG F	DAYTIME AMBIENT TEMP DEG F	RELATIVE HUMIDITY PERCENT	WIND DIRECTION DEGREES	WIND SPEED M.P.H.
1	1107	690	40	50	N	N	N
2	131	97	39	40	O	O	O
3	752	574	38	42	T	T	T
4	101	72	37	38			
5	192	139	49	52	A	A	A
6	13	5	50	50	P	P	P
7	198	148	43	44	P	P	P
8	1634	1002	41	47	L	L	L
9	1894	821	41	50	I	I	I
10	106	72	42	45	C	C	C
11	526	373	33	33	A	A	A
12	2047	941	29	34	B	B	B
13	1830	628	37	*	L	L	L
14	315	232	47	*	E	E	E
15	2288	1206	25	26			
16	1987	1048	27	32			
17	405	335	35	*			
18	2258	795	36	45			
19	2205	774	40	49			
20	2106	887	46	53			
21	2017	771	49	60			
22	2249	718	54	70			
23	2128	704	51	68			
24	495	378	52	59			
25	1678	735	51	58			
26	1181	805	40	45			
27	2207	767	36	43			
28	2126	730	36	46			
29	556	323	45	49			
30	492	303	54	62			
31	1066	535	53	57			
SUM	38291	17607	-	-	-	-	-
AVG	1235	568	42	48	N.A.	N.A.	N.A.
NBS ID	Q001		N113			N115	N114

* DENOTES UNAVAILABLE DATA.
@ DENOTES NULL DATA.
N.A. DENOTES NOT APPLICABLE DATA.

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